JULY 23, 1984

CHEMICAL & ENGINEERING

NEWS

Pesticide chemists examine new concepts in pest control
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R&D
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CHEMICAL & ENGINEERING NEWS

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JULY 23, 1984

News of the Week

■ **U.S. chemical companies' profits continue to increase robustly in second quarter.** **Page 6**

■ **Merrell Dow Pharmaceuticals will set up $120 million fund to settle claims involving Bendectin.** **Page 7**

■ **Eastman Kodak chemical division will move animal nutrition research to new facility to be built at Kingsport, Tenn.** **Page 7**

■ **Two candidates for the ACS Board of Directors have been nominated by petition.** **Page 7**

■ **Two laser systems being developed by DOE set records for energy, power output.** **Page 8**

■ **Soviet officials may be using psychotropic drugs on dissident physicist Andrei Sakharov.** **Page 8**

Business

The U.S. chemical industry will continue to prosper through the second half of the year although the pace may slow. **Page 14**

Government

Council on Environmental Quality's annual report emphasizes R&D of federal agencies, calls for national research policy. **Page 16**

Science

Pesticide chemists join members of other disciplines to search for ways to control pests rather than kill them. **Page 22**

Creation of two unusual rhenium complexes may help researchers learn how oxo species interact with organic molecules. **Page 26**

Books

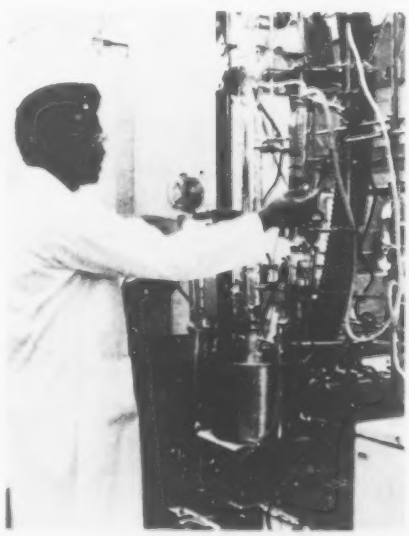
"**Regulation and the Courts**" examines the role of the judiciary in shaping the evolution of the Clean Air Act. **Page 69**

ACS News

Four petitions await council action at the Philadelphia meeting; one concerns increase in local section allotments. **Page 71**

Physics Briefs file, which can be searched on STN International, contains reports on worldwide physics publications. **Page 77**

Cover: Photo courtesy of Uniroyal



Special Report

U.S. spending for chemical R&D this year is expected to rise 12% to almost $12 billion; basic research is growing most actively. **Page 37**

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Environment Council Report Stresses R&D

The President's Council on Environmental Quality released its 14th annual report last week, amidst one of the hottest periods of environmental activity in Washington, D.C., in recent years.

Environmental groups were appalled when the President appointed former Environmental Protection Agency Administrator Anne M. Burford to a federal advisory panel at the National Oceanic & Atmospheric Administration. However, the President saw no problem with the appointment and he proceeded to go on a highly publicized three-day environmental goodwill tour. It was on this trip, while visiting Theodore Roosevelt Island (named after the President who championed wildlife and conservation) in the Potomac River that Reagan released CEQ's report.

CEQ reports often are viewed as platforms that give an Administration credit for whatever it has done well and avoid talking about what it has not done well. They are traditionally divided into the various resources that are polluted—water, land, or air. But this year's report devotes scant attention to these traditional areas, mostly pointing out that improvements begun in the 1970s have continued.

One section that is a departure from past reports is an entire chapter devoted to the state of environmental research and development. CEQ divides the government's efforts into four categories, then discusses each separately. These are environmental health research, which includes toxicology, epidemiology, and clinical studies; ecosystems research, greatly concerned with predictive mathematical models and studies of existing patterns; environmental processes, where the whole range of chemical and biological cycles is studied; and technology research, which includes forecasting the effects of technological changes on the environment, as well as the monitoring and control of pollutants.

Broken down this way, it is interesting to find that EPA is only the fourth largest funder of environmental research. Basic research funded by the National Science Foundation, and toxicological and epidemiological research funded by the Department of Energy and the National Institute of Environmental Health Sciences all outweigh the support from EPA. This scattered effort has given rise to a call for a national environmental research policy that would combine some of these efforts. CEQ believes that the time is not right for that, but does agree that there would be a substantial benefit from better coordination of research and sharing of the research results among federal agencies.

Two areas not receiving much space in the report are toxic wastes and acid rain. As the premier issues of public concern, the absence of lengthy discussions of their current status and cleanup programs is a disappointment. Three scattered discussions on acid rain are presented, one dealing with international problems, one with its alleged impact on water quality, and the third on the relationship of acid rain to sulfur dioxide and nitrogen oxide emissions. Much of the discussion seems to minimize the problem, with references to the natural acidity of rain and to the relatively few lakes in the Northeast that have lost fish from acidity. Still, with the awareness of this issue so high, more detailed analysis and data on the problem could have been expected.

Toxic wastes get similar short shrift, although there seems to be no attempt to sugarcoat the problem. The seriousness of abandoned toxic waste sites is adequately chronicled, and federal and state programs (as well as the efforts of environmental and industry groups) are also listed, but it is hard to get any perspective on the issues from the CEQ report.

Copies of the CEQ report, Environmental Quality 1983, can be purchased for $8.00 from Superintendent of Documents, Washington, D.C. 20402, stock number 041-011-00077-7. □

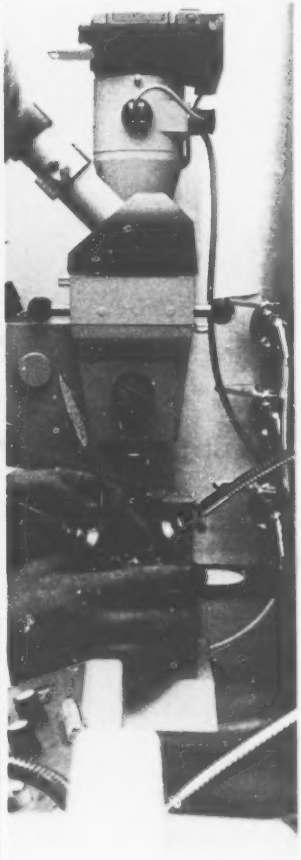
Federal spending on environment research is widespread

$ Millions[a]	Environmental health	Ecological systems	Ecological processes	Technology
Defense Department	$ 5	$ 42	$ 25	$ 1
Energy Department	83	30	51	63
Environmental Protection Agency	50	24	37	49
Interior Department	0	9	20	2
National Aeronautics & Space Administration	0	0	32	0
National Cancer Institute	127	0	0	0
National Institute of Environmental Health Sciences	173	0	0	0
National Institute for Occupational Safety & Health	15	0	0	0
National Oceanic & Atmospheric Administration	0	11	29	0
National Science Foundation	0	40	277	6
National Toxicology Program	76	0	0	0
TOTAL	$529	$116	$471	$121

a Resources are approximate because of inconsistent agency interpretations of defined research. Note: Agriculture Department's environmental research is not included because it cannot be split out of larger programs.
Source: Council on Environmental Quality

Facts & Figures for

Chemical



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R&D

Among the significant trends in U.S. spending for research and development this year is the increasing emphasis on basic research. Total spending by all sources for such research is expected to rise 12% to $11.9 billion in 1984. (In contrast, outlays for basic research were up only 7% last year and 8% in 1982.) This year, total spending will grow 8% for applied research and 11% for development. Clearly, the area of most active growth today is basic research.

The federal government's support of basic research will rise 9% this year to $6.6 billion. At the same time, its support of applied research is expected to decline less than 1% to $8.0 billion.

The government's position was clearly stated early this year by President Reagan, who, in his annual budget message to Congress, described basic research as "a critical investment in the nation's future," that lays the foundation for "new technologies and industries that will maintain U.S. industrial leadership, create new jobs, and improve our quality of life."

The Administration believes that it must give substantial monetary support to basic research to fill the gap left by industry's primary interest in applied research and development—although industry does carry a sizable part of the basic research load. The government's support of basic research mainly takes the form of grants to universities, which perform the majority of the nation's fundamental research.

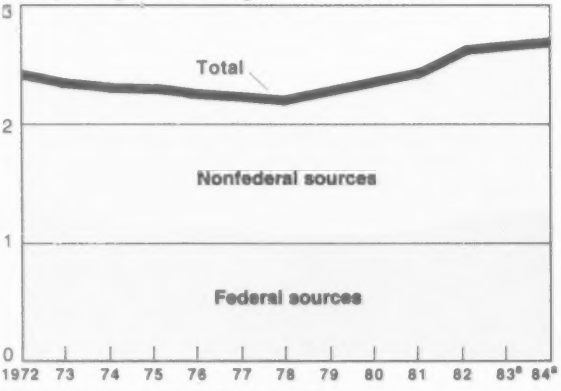
Another significant trend is the declining percentage of total funding for R&D coming from the federal government. In 1965, 65% of all R&D funds were supplied by the government and the remaining 35% by nonfederal sources. Now, the government supplies 46% of the total, whereas nonfederal sources (chiefly industry) furnish 54%. The government strongly endorses this trend because it believes that, if industry carries most of the financial burden for R&D, the results are more likely to reach the marketplace. Also, industry, it points out, is the chief financial benefactor of R&D.

Among other trends are the recent changes in the government's funding of R&D in its own departments and agencies. Most notable is that federal R&D funding of the Department of Defense increased a hefty 29% from $23.1 billion in fiscal 1983 to $29.7 billion in fiscal 1984. This reflects the Administration's emphasis on increasing U.S. military strength.

As evidence of the government's concern about expanding the nation's basic research effort, the National Science Foundation, which supplies a large share of federal money for basic research at universities, saw its total R&D funding rise to $1.24 billion in 1984—a gain of 17%. Of the NSF total, the support of basic research is up 18% to $1.18 billion in 1984.

R&D's share of GNP changed little in past three years

R&D spending as % of U.S. gross national product



a Estimated. **Source:** National Science Foundation

For some federal departments or agencies, however, funding for R&D has been cut in fiscal 1984. Among these are the departments of Agriculture, Commerce, Energy, and Interior, and the Environmental Protection Agency. These reductions are due partly to the Administration's desire to reduce federal spending and diminish the federal deficit. The Department of Energy's 2% drop in R&D funding between fiscal 1983 and 1984 is caused partly by reduced support for high-cost demonstration projects, such as synthetic fuel plants, coal liquefaction projects, and breeder reactors.

In 1984, total R&D spending as a percentage of the U.S. gross national product rose to 2.7%, the highest level in more than a decade. Six years ago, R&D's share of GNP was barely more than 2%. The present level is believed to be the highest for any nation in the world, with the possible exception of the Soviet Union. Many observers expect the U.S. figure to rise still higher in the years ahead, but obviously no one knows to what level it ultimately may climb. □

R & D funding to rise 11% this year

With basic research slated for a healthy increase, real outlays for R&D will score the heftiest gain since the mid-1960s

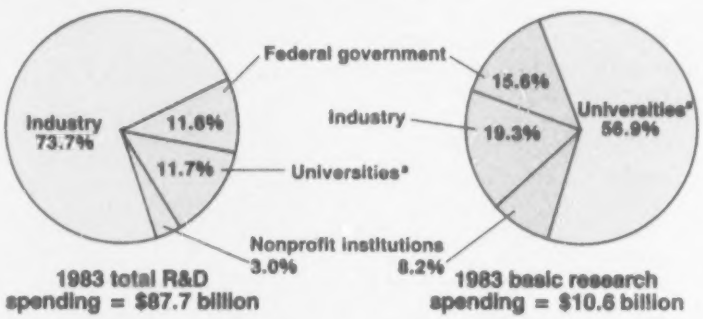
Total spending in the U.S. on research and development, according to the National Science Foundation, is expected to reach $97.0 billion this year, an increase of 11% over the 1983 level. In constant dollars, this constitutes a gain of 6%, well above the 4% average annual increase in R&D spending over the period of 1974 to 1984 and the biggest annual gain since the 1960s.

For the past five years, industry has been the leading supporter of R&D. In 1980, 49% of all R&D funds came from industry, 47% from the federal government, and the remaining 4% from other sources. In 1984, industry's share will rise to 51%, that of the government will decline to 46%.

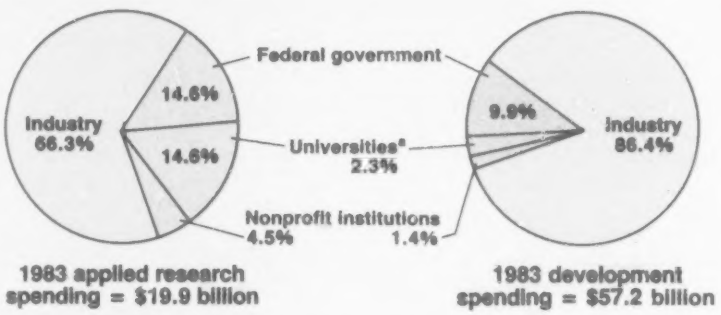
For decades, industry, partly with financial help from the federal government, has been by far the chief performer of R&D. Back in 1974, industry spent 70% of all the money expended on the performance of R&D, whereas the government spent 15%. In 1984, 74% of R&D money will be spent by industry and 11% will be spent by the government.

Universities, as they have for some years, do most of the nation's basic research. On the other hand, industry performs the bulk of the applied research and development work. □

Despite the universities' key role in basic research, nearly three fourths of all R&D is done by industry . . .



. . . because industrial firms perform by far the biggest portion of applied research and development work



a Includes associated federally funded research and development centers.
Source: National Science Foundation

TRENDS IN R&D: Defense R&D captures its biggest share of total R&D funding since 1973

% of total outlays	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965
Federal	46%	46%	46%	46%	47%	49%	50%	50%	51%	51%	51%	53%	56%	56%	57%	58%	61%	62%	64%	65%
Defense related	29	27	25	23	22	23	24	25	26	26	27	30	32	32	33	34	35	35	33	33
Space related	6	6	7	7	7	7	7	8	8	8	8	8	9	9	10	11	13	14	19	21
Civilian related	11	13	14	16	18	19	19	17	17	17	16	15	15	15	14	13	13	13	12	11
Nonfederal	54	54	54	54	53	51	50	50	49	49	49	47	44	44	43	42	39	38	36	35

a Estimated Source: National Science Foundation

SOURCES OF R&D FUNDS: Industry maintains its lead as the largest source of R&D money . . .

$ Billions, current	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1983–84	Annual change 1974–84
Federal government	$44.3	$40.3	$37.1	$33.4	$29.5	$26.8	$23.9	$21.6	$19.9	$18.1	$16.9	10%	10%
Industry	49.4	44.4	40.5	36.0	30.9	26.1	22.5	19.6	17.7	15.8	14.9	11	13
Universities and colleges	2.1	1.9	1.7	1.5	1.3	1.2	1.0	0.9	0.8	0.7	0.7	12	12
Other nonprofit institutions	1.3	1.1	1.1	1.0	0.9	0.8	0.8	0.7	0.6	0.5	0.5	10	10
TOTAL	**$97.0**	**$87.7**	**$80.3**	**$71.9**	**$62.6**	**$54.9**	**$48.1**	**$42.8**	**$39.0**	**$35.2**	**$32.9**	**11%**	**11%**

a Estimated. **Source:** National Science Foundation

. . . although expansion in all sectors is slashed by inflation

$ Billions, constant (1972)	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1983–84	Annual change 1974–84
Federal government	$19.6	$18.6	$17.8	$17.1	$16.5	$16.4	$15.9	$15.4	$15.1	$14.5	$14.8	5%	3%
Industry	21.9	20.6	19.6	18.4	17.3	16.0	14.9	14.0	13.4	12.6	12.9	7	6
Universities and colleges	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.6	7	4
Other nonprofit institutions	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	5	4
TOTAL	**$43.0**	**$40.6**	**$38.7**	**$36.9**	**$35.1**	**$33.6**	**$32.0**	**$30.5**	**$29.5**	**$28.2**	**$28.8**	**6%**	**4%**

a Estimated. **Source:** National Science Foundation

PERFORMERS OF R&D: Industry spends about three fourths of all dollars for R&D . . .

$ Billions, current	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1983–84	Annual change 1974–84
Industry	$72.0	$64.6	$59.0	$51.9	$44.5	$38.2	$33.3	$29.8	$27.0	$24.2	$22.9	11%	12%
Federal government	10.8	10.2	9.1	8.4	7.6	7.4	6.8	6.0	5.8	5.4	4.9	6	8
Universities and colleges	8.6	7.7	7.3	6.8	6.1	5.4	4.6	4.1	3.7	3.4	3.0	12	11
Associated FFRDCs[b]	2.8	2.6	2.5	2.5	2.2	1.9	1.7	1.4	1.1	1.0	0.9	7	12
Other nonprofit institutions	2.8	2.6	2.4	2.3	2.2	2.0	1.7	1.5	1.4	1.3	1.2	9	9
TOTAL	**$97.0**	**$87.7**	**$80.3**	**$71.9**	**$62.6**	**$54.9**	**$48.1**	**$42.8**	**$39.0**	**$35.2**	**$32.9**	**11%**	**11%**

a Estimated. b Federally funded research and development centers administered by universities and colleges. **Source:** National Science Foundation

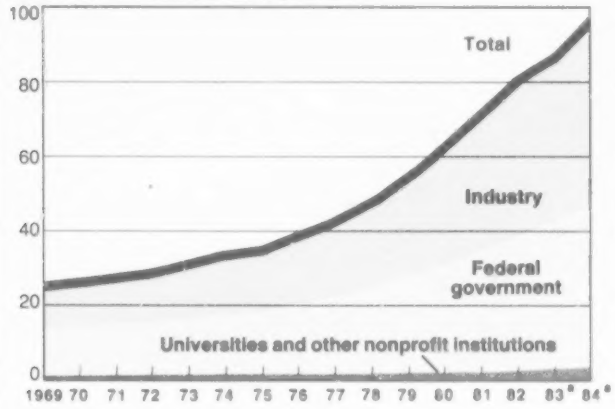
. . . and makes a big gain in spending this year in constant dollars

$ Billions, constant (1972)	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1983–84	Annual change 1974–84
Industry	$31.9	$30.0	$28.5	$26.6	$24.9	$23.4	$22.1	$21.3	$20.4	$19.2	$19.3	7%	5%
Federal government	4.8	4.7	4.4	4.3	4.3	4.5	4.5	4.3	4.4	4.3	4.4	1	9
Universities and colleges	3.8	3.5	3.5	3.5	3.4	3.3	3.1	2.9	2.8	2.8	2.7	7	3
Associated FFRDCs[b]	1.2	1.2	1.2	1.3	1.3	1.2	1.1	1.0	0.9	0.8	0.8	2	4
Other nonprofit institutions	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	4	2
TOTAL	**$43.0**	**$40.6**	**$38.7**	**$36.9**	**$35.1**	**$33.6**	**$32.0**	**$30.5**	**$29.5**	**$28.2**	**$28.8**	**6%**	**4%**

a Estimated. b Federally funded research and development centers administered by universities and colleges. **Source:** National Science Foundation

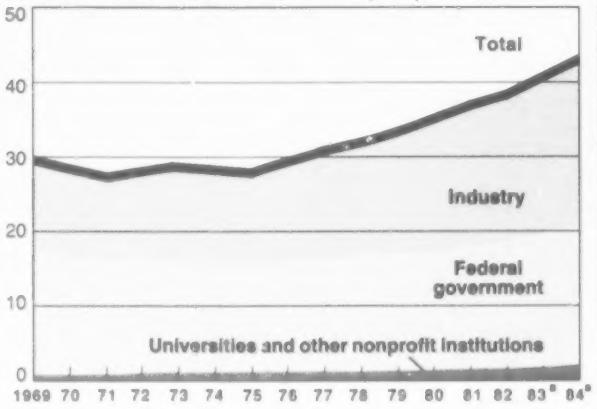
U.S. spending for R&D has increased steadily to near the $100 billion level . . .

Sources of R&D funds, $ billions, current



. . . and has managed to outdistance inflation since 1975

Sources of R&D funds, $ billions, constant (1972)



a Estimated. **Source:** National Science Foundation

CHARACTER OF R&D: Outlays for basic research will get a healthy boost this year . . .

$ Billions, current	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1983–84	Annual change 1974–84
Basic research	$11.9	$10.6	$ 9.9	$ 9.2	$ 8.1	$ 7.3	$ 6.4	$ 5.5	$ 5.0	$ 4.6	$ 4.2	12%	11%
Applied research	21.4	19.9	18.4	16.9	14.1	12.4	10.8	9.7	9.0	7.9	7.2	8	12
Development	63.7	57.2	52.0	45.8	40.5	35.3	30.9	27.5	25.0	22.7	21.4	11	12

a Estimated. **Source:** National Science Foundation

. . . but have shown the slowest growth, in real dollars, over the past decade

$ Billions, constant (1972)	1984[a]	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1982–84	Annual change 1974–84
Basic research	$ 5.2	$ 4.9	$ 4.7	$ 4.7	$ 4.5	$ 4.4	$ 4.3	$ 3.9	$ 3.8	$ 3.7	$ 3.8	7%	3%
Applied research	9.5	9.2	8.9	8.7	7.9	7.6	7.2	6.9	6.8	6.3	6.3	3	4
Development	28.2	26.5	25.1	23.5	22.7	21.6	20.5	19.6	18.9	18.1	18.7	7	4

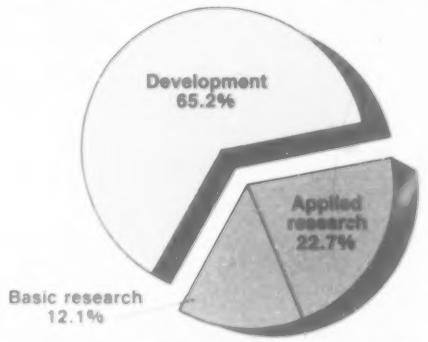
a Estimated. **Source:** National Science Foundation

EMPLOYED SCIENTISTS AND ENGINEERS: 8% are chemists and chemical engineers

	Thousands employed	Per cent
Scientists	1405.8	43.2%
Physical scientists	227.4	7.0
Chemists	154.1	4.7
Physicists/astronomers	47.6	1.5
Other physical scientists	25.7	0.8
Other scientists	1178.4	36.2
Engineers	1847.2	56.8
Chemical engineers	107.7	3.3
Other engineers	1739.5	53.5
TOTAL	3253.0	100.0%

Note: 1982 data. **Source:** National Science Foundation

Research itself accounts for little more than two thirds of total R&D outlays



1983 total R&D spending = $87.7 billion

Source: National Science Foundation

ABSTRACTS OF PAPERS IN *CHEMICAL ABSTRACTS:* Biochemistry's share dips slightly

% IN EACH GROUP	1983	1982	1981	1980	1979	1978	1977	1976	1975
Biochemistry	38.3%	39.5%	39.0%	39.8%	38.8%	38.3%	37.9%	38.8%	39.4%
Physical, inorganic, and analytical chemistry	29.6	28.5	28.0	28.6	28.9	27.4	27.9	27.5	29.6
Applied chemistry and chemical engineering	19.4	19.5	19.1	18.9	19.4	20.8	19.7	18.8	15.5
Organic chemistry	7.3	7.2	8.7	7.4	7.6	8.0	8.8	8.7	9.0
Macromolecular chemistry	5.4	5.3	5.2	5.3	5.3	5.5	5.7	6.2	6.5
% OF ALL BIOCHEMISTRY ABSTRACTS									
Mammalian biochemistry[a]	11.1%	11.6%	15.6%	16.3%	17.1%	17.2%	17.7%	16.3%	15.3%
Pharmacology	11.8	12.0	12.4	12.0	11.9	12.3	12.0	12.0	12.0
Toxicology	8.5	8.1	8.7	8.3	7.4	7.5	6.2	6.4	6.6
General biochemistry	5.8	6.0	7.5	6.6	7.0	6.5	7.0	7.1	7.5
Enzymes	6.1	5.9	5.9	6.2	6.4	5.7	6.1	6.4	7.4
Others	56.7	56.4	49.9	50.6	50.2	50.8	51.0	51.8	51.2
% OF ALL PHYSICAL, INORGANIC, AND ANALYTICAL CHEMISTRY ABSTRACTS									
Nuclear chemistry	22.5%	22.6%	21.6%	23.2%	25.1%	20.7%	21.1%	19.7%	20.0%
Spectra	17.6	17.2	18.0	18.2	17.0	17.0	18.1	17.8	17.2
Electric phenomena	10.0	10.5	11.0	11.2	11.4	10.9	10.5	10.5	10.3
Crystallography and liquid crystals	8.3	8.7	8.9	8.1	8.2	9.2	8.9	9.7	9.6
General physical chemistry	7.3	7.3	7.2	7.1	6.6	6.6	6.8	7.0	6.8
Analytical chemistry	6.2	5.4	5.8	5.6	5.6	7.2	5.8	6.6	6.1
Others	28.1	28.3	27.5	26.6	25.8	28.4	28.8	28.7	30.0
% OF ALL APPLIED CHEMISTRY AND CHEMICAL ENGINEERING ABSTRACTS									
Metals and alloys	19.1%	22.2%	17.9%	22.0%	23.6%	24.0%	24.2%	27.8%	24.4%
Water, wastes, and pollution	19.6	21.7	24.0	22.5	20.8	20.8	23.2	18.6	15.2
Mineralogical and geological chemistry	14.1	13.6	14.1	15.7	15.8	16.8	13.4	17.6	17.5
Fossil fuels, derivatives, and related products	10.3	9.4	9.4	8.9	7.8	8.2	9.2	6.0	9.8
Unit operations and processes	7.5	6.9	6.4	6.0	6.1	6.4	5.8	4.8	5.3
Others	29.4	26.2	28.2	24.9	25.9	23.8	24.2	25.2	27.8
% OF ALL ORGANIC CHEMISTRY ABSTRACTS									
Physical organic chemistry	30.5%	31.5%	37.0%	38.8%	38.8%	36.8%	41.3%	38.4%	40.8%
Heterocyclic compounds[a]	16.2	15.6	18.2	17.3	16.0	17.5	17.0	17.4	16.4
Organometallic and organometalloidal compounds[a]	16.3	14.8	8.3	8.2	8.5	8.9	8.5	8.7	8.4
Aromatic compounds[a]	7.1	7.2	8.7	7.8	8.2	8.6	8.5	8.0	8.7
Aliphatic compounds[a]	4.3	5.2	6.6	6.0	6.0	6.9	5.9	6.5	6.3
Carbohydrates	5.8	5.8	5.4	5.7	6.0	5.2	4.6	5.1	4.9
Others	19.8	19.9	15.8	16.2	16.5	16.1	14.2	15.9	14.5
% OF ALL MACROMOLECULAR CHEMISTRY ABSTRACTS									
Synthetic high polymers	34.4%	34.7%	30.3%	27.0%	26.3%	25.6%	26.5%	28.3%	30.6%
Plastics manufacture and uses	24.4	21.9	26.4	28.1	27.8	28.1	27.5	26.8	23.3
Cellulose, lignin, paper and other wood products	9.1	9.7	10.1	10.9	11.1	10.6	10.0	9.1	9.2
Textiles	7.9	8.9	9.9	10.1	10.1	12.1	11.0	11.1	10.2
Coatings, inks, and related products	6.6	7.6	7.5	7.4	8.1	7.5	7.5	7.6	7.3
Synthetic elastomers and natural rubber	7.5	7.8	7.9	8.4	7.6	8.0	8.5	8.6	9.2
Others	10.1	9.4	7.9	8.1	9.0	8.1	9.0	8.5	10.2

a Definition of section content changed in 1982. **Source:** Chemical Abstracts Service

U.S. PATENTS: Total declines but percentage granted to foreign residents continues to rise

	1983	1982	1981	1980	1979[a]	1978	1977	1976	1975	1974	1973
U.S.[b]	32,872	33,896	37,356	37,152	30,605	40,979	41,383	44,162	46,603	50,643	51,501
Foreign[c]	23,990	23,993	24,463	24,675	18,248	25,123	23,886	26,074	25,291	25,632	22,638
TOTAL	**56,862**	**57,889**	**61,819**	**61,827**	**48,853**	**66,102**	**65,269**	**70,236**	**71,994**	**76,275**	**74,139**
% Foreign	**42.2%**	**41.4%**	**39.6%**	**39.9%**	**37.4%**	**38.0%**	**36.6%**	**37.1%**	**35.3%**	**33.6%**	**30.5%**

a Patent figures were low in 1979 because the Patent & Trademark Office was short of funds to print patents it might otherwise have issued. b U.S. patents granted to U.S. residents. c U.S. patents granted to residents of foreign countries. **Source:** Patent & Trademark Office

Defense wins most of this year's increase

FEDERAL OBLIGATIONS FOR R&D: Some major agencies suffer cuts in 1984

Department or agency	Total R&D ($ millions) 1984[a]	1983[a]	1982	1981	1980
Agriculture	**$ 848.4**	**$ 852.9**	**$ 797.3**	**$ 774.0**	**$ 687.6**
Agricultural Research Service	456.3	445.0	404.9	394.1	351.8[b]
Cooperative State Research Service	221.7	234.9	219.0	199.4	184.2[c]
Commerce	**234.3**	**338.6**	**336.3**	**328.0**	**342.5**
National Bureau of Standards	78.0	93.6	88.8	82.5	76.2
National Oceanic & Atmospheric Administration	142.1	220.5	222.0	201.4	199.8
Defense	**29,735.5**	**23,125.1**	**20,622.6**	**16,508.6**	**13,981.0**
Air Force	13,864.0	10,937.3	9,357.9	6,969.2	5,211.0
Army	4,904.1	3,965.0	3,760.5	3,244.2	2,980.0
Navy	8,063.3	6,043.7	5,845.1	5,006.0	4706.1
Defense agencies[d]	2,847.8	2,115.3	1,618.1	1,248.2	1,046.0
Energy	**4,516.8**	**4,605.4**	**4,708.2**	**4,918.2**	**4,753.7**
Environmental Protection Agency	**207.7**	**240.8**	**335.1**	**235.7**	**345.0**
Health & Human Services	**4,434.8**	**4,326.7**	**3,940.7**	**3,927.1**	**3,780.2**
National Institutes of Health	3,853.2	3,773.7	3,433.1	3,333.2	3,181.8
Interior	**327.8**	**397.1**	**381.1**	**427.1**	**411.3**
National Aeronautics & Space Administration	**2,462.5**	**2,416.0**	**3,077.9**	**5,406.6**	**5,084.1**
National Science Foundation	**1,240.5**	**1,060.2**	**975.3**	**961.6**	**881.8**
Tennessee Valley Authority	**78.3**	**74.9**	**85.0**	**68.9**	**80.1**
Others	**1,410.4**	**1,272.4**	**1,173.1**	**1,271.6**	**1333.1**
TOTAL	**$45,497.0**	**$38,710.1**	**$36,432.6**	**$34,917.4**	**$31,680.4**

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. d Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR RESEARCH: Funding for defense research jumps 13%

Department or agency, $ millions	1984[a] Basic research	1984[a] Applied research	1983[a] Basic research	1983[a] Applied research	1982 Basic research	1982 Applied research	1981 Basic research	1981 Applied research	1980 Basic research	1980 Applied research
Agriculture	**$ 380.8**	**$ 438.1**	**$ 363.3**	**$ 459.2**	**$ 330.8**	**$ 435.7**	**$ 314.1**	**$ 426.9**	**$ 275.7**	**$ 381.8**
Agricultural Research Service	235.9	194.7	217.1	202.3	192.9	186.2	186.4	181.5	157.8[b]	170.8[b]
Cooperative State Research Service	95.6	126.1	97.6	137.3	91.3	127.7	83.9	115.5	75.2[c]	109.0[c]
Commerce	**16.5**	**183.2**	**18.0**	**262.2**	**16.9**	**259.2**	**16.2**	**233.2**	**15.9**	**238.5**
National Bureau of Standards	15.7	55.1	17.2	62.9	16.5	57.4	15.6	50.6	12.8	46.1
National Oceanic & Atmospheric Administration	0	118.6	0	187.4	0	188.5	0	168.5	14.0	154.8
Defense	**868.5**	**2703.7**	**769.8**	**2391.7**	**686.7**	**2266.1**	**604.3**	**1996.6**	**540.3**	**1721.4**
Air Force	206.6	526.0	157.6	499.0	145.8	488.1	125.8	491.5	108.2	429.1
Army	220.4	525.5	195.0	458.0	187.7	451.6	148.1	388.4	132.2	347.1
Navy	330.2	552.8	314.0	507.9	280.3	498.4	238.0	460.0	214.9	396.2
Defense agencies[d]	111.3	1099.4	103.3	926.8	72.9	828.1	92.4	656.7	85.1	549.1
Energy	**800.8**	**1029.8**	**717.1**	**1251.5**	**642.2**	**1,053.9**	**586.3**	**827.3**	**523.1**	**754.2**
Environmental Protection Agency	**17.4**	**131.2**	**20.7**	**153.2**	**32.7**	**210.7**	**10.5**	**207.8**	**13.6**	**231.5**
Health & Human Services	**2468.1**	**1625.6**	**2388.4**	**1584.3**	**2144.7**	**1460.9**	**1900.4**	**1591.9**	**1762.7**	**1570.1**
National Institutes of Health	2305.1	1217.7	2243.9	1199.4	2020.7	1103.8	1766.8	1181.5	1642.3	1145.1
Interior	**89.7**	**220.7**	**100.0**	**268.7**	**76.5**	**275.0**	**80.7**	**289.2**	**71.6**	**282.8**
National Aeronautics & Space Administration	**681.5**	**965.4**	**604.7**	**956.9**	**535.7**	**871.4**	**531.1**	**876.0**	**559.1**	**1050.5**
National Science Foundation	**1181.1**	**59.4**	**998.5**	**61.7**	**916.1**	**57.1**	**896.6**	**58.9**	**815.2**	**58.4**
Tennessee Valley Authority	**5.7**	**7.5**	**5.5**	**10.0**	**4.6**	**8.1**	**4.8**	**9.4**	**4.6**	**11.2**
Others	**105.3**	**683.3**	**100.0**	**668.9**	**94.7**	**642.5**	**96.3**	**654.3**	**92.4**	**622.8**
TOTAL	**$6615.4**	**$8047.9**	**$6086.0**	**$8068.3**	**$5481.6**	**$7540.6**	**$5041.3**	**$7171.5**	**$4674.2**	**$6923.2**

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. d Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: Chemistry makes good gain in 1984

$ Millions for research only	1984[a]	1983[a]	1982	1981	1980	Annual change 1983–84	Annual change 1980–1984
Engineering	$ 3,487	$ 3,501	$ 3,387	$ 3,072	$ 2,830	0%	5%
Chemical	108	139	95	148	96	−22	3
Metallurgy and materials	360	336	309	256	236	7	11
Environmental sciences	1,189	1,219	1,148	1,121	1,261	−2	−1
Life sciences	5,251	5,133	4,745	4,436	4,192	2	6
Mathematics and computer sciences	482	399	350	279	241	21	19
Physical sciences	3,179	2,852	2,500	2,221	2,001	11	12
Chemistry	529	477	481	487	455	11	4
Physics	2,078	1,867	1,611	1,346	1,183	11	15
Other sciences	1,075	1,050	892	1,085	1,072	2	0
TOTAL	$14,663	$14,154	$13,022	$12,213	$11,597	4%	6%

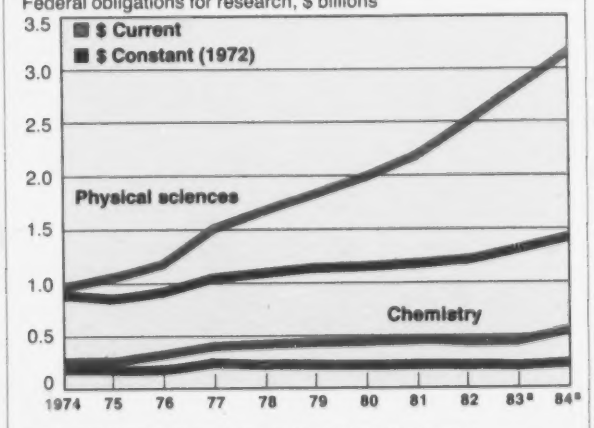
a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR DEVELOPMENT: Defense takes a growing share of funds

Department or agency	Development ($ millions) 1984[a]	1983[a]	1982	1981	1980
Agriculture	$ 29.5	$ 30.4	$ 30.8	$ 33.0	$ 30.2
Agricultural Research Service	25.8	25.7	25.8	26.2	23.3[b]
Cooperative State Research Service	0	0	0	0	0[c]
Commerce	34.6	58.5	60.2	78.6	88.1
National Bureau of Standards	7.1	13.5	14.9	16.3	17.3
National Oceanic & Atmospheric Administration	23.5	33.1	33.5	32.9	30.9
Defense	26,163.3	19,963.6	17,669.8	13,907.7	11,719.2
Air Force	13,131.4	10,280.7	8,724.0	6,351.9	4,673.7
Army	4,158.2	3,312.1	3,121.3	2,707.7	2,500.7
Navy	7,180.3	5,221.8	5,066.4	4,308.0	4,095.0
Defense agencies[d]	1,637.1	1,085.2	717.1	499.1	411.9
Energy	2,686.2	2,636.8	3,012.1	3,504.6	3,476.4
Environmental Protection Agency	59.1	66.9	91.7	107.4	99.9
Health & Human Services	341.1	354.0	335.2	434.9	447.4
National Institutes of Health	330.4	330.3	308.7	384.9	394.4
Interior	17.3	28.4	29.6	57.3	56.8
National Aeronautics & Space Administration	815.6	854.4	1,670.7	3,999.4	3,474.4
National Science Foundation	0	0	2.2	6.1	8.1
Tennessee Valley Authority	65.1	59.4	72.3	54.7	54.3
Others	622.0	503.3	435.8	520.9	618.2
TOTAL	$30,833.8	$24,555.7	$23,410.4	$22,704.6	$20,083.0

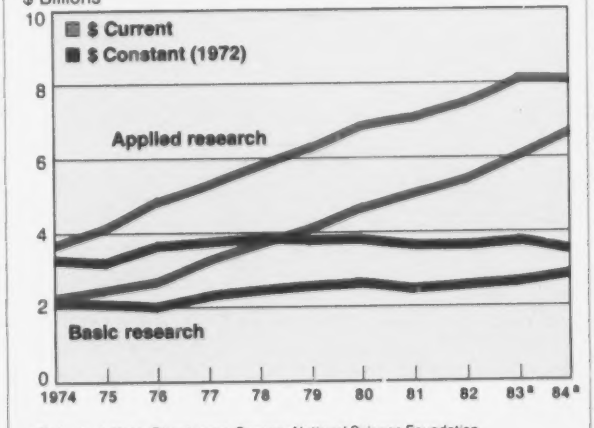
a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. d Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

Government support for chemistry edges above half-billion-dollar mark



a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

Federal funds rise for basic research but drop for applied, in real terms



a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

R&D appropriations to research-oriented federal agencies for fiscal 1985 generally are up strongly

DEPARTMENT OF ENERGY R&D BUDGET: Funding has its ups and downs

$ Millions	1985 Congressional appropriation	1985 Administration request	1984[a]	1983	1982	% change 1984–85[b]
Defense R&D	$1036.0	$1085.2	$ 825.8	$ 742.2	$ 508.1	25%
General science and research	727.6	746.8	641.2	534.5	500.1	13
Nuclear	626.3	623.0	674.6	856.5	871.7	−7
Supporting research and technical analysis	481.0	479.6	395.1	293.2	269.6	22
Fusion	440.1	483.1	470.7	462.2	256.3	−7
Fossil energy	267.5[c]	200.0	260.2	217.1	417.7	3
Environment	229.7	226.2	216.0	182.5	213.6	6
Solar	179.4	163.6	181.6	203.0	252.4	−1
Conservation	139.5[c]	119.6	160.2	116.1	152.3	−13
Electric energy systems and storage	38.6	37.1	44.2	42.5	58.3	−13
Geothermal	32.1	27.1	30.4	78.2	41.3	6
TOTAL	**$4197.8**	**$4191.3**	**$3900.0**	**$3728.0**	**$3541.4**	**8%**

a Estimate. b Based on estimated Congressional appropriation. c Based on minimal action to date. **Note.** Fiscal years ending Sept. 30.

NSF BUDGET: Engineering and physical sciences are big gainers in an overall 13% increase

$ Millions	1985 Congressional appropriation	1985 Administration request	1984[a]	1983	1982	% change 1984–85
Mathematical and physical sciences	$ 418.5[b]	$ 416.7	$ 358.8	$ 300.4	$272.8	17%
Astronomical, atmospheric, Earth, and ocean sciences	366.9[b]	373.5	330.0	280.8	259.8	11
Biological, behavioral, and social sciences	256.1	253.1	223.6	191.2	176.6	15
Engineering	145.1[b]	147.1	120.7	101.1	93.3	20
Antarctic program	110.1	115.1	102.4	83.2	68.5	8
Science education activities	87.0	75.7	75.0	30.0	21.0	16
Program development and management	70.3	70.9	66.6	65.7	63.2	6
Scientific, technological, and international affairs	41.4[b]	46.9	40.8	44.1	40.3	1
Special foreign currency	2.8	2.8	2.9	2.2	3.1	−3
TOTAL	**$1498.2**	**$1501.8**	**$1320.8**	**$1098.7**	**$998.6**	**13%**

a Estimate. b Reflects one-quarter share of $36.3 million general unspecified reductions. **Note:** Fiscal years ending Sept. 30.

EPA R&D BUDGET: Congress tops Administration request, boosting funds above 1982 spending

$ Millions	1985 Congressional appropriation	1985 Administration request	1984[a]	1983	1982	% change 1984–85
Air	$ 75.9	$ 65.2	$ 62.3	$ 60.0	$ 63.2	11%
Energy	48.5	48.5	30.4	26.7	62.3	60
Hazardous waste	40.2	34.8	32.3	33.4	29.2	45
Toxic substances	34.8	27.1	24.4	26.8	34.1	43
Water quality	31.8	26.8	24.8	31.6	53.5	28
Drinking water	26.1	23.1	23.8	21.8	30.9	10
Interdisciplinary	23.9	20.4	21.3[b]	9.8	6.7	12
Superfund	12.7	12.7	8.8	6.9	13.8	44
Pesticides	10.0	8.0	6.3	6.1	7.1	59
Program management	9.3	9.3	8.5	8.9	7.9	9
Radiation	2.1	2.1	1.8	1.5	2.6	17
TOTAL	**$315.3**	**$278.0**	**$244.7**	**$233.5**	**$311.3**	**29%**

a Estimate. b Not an increase in total budget, reflects consolidation of other programs into the interdisciplinary program. **Note:** Fiscal years ending Sept. 30.

CIRCLE 39 ON READER SERVICE CARD →

NASA BUDGET: 20% increase for R&D as work starts on space station

$ Millions	1985 Congressional appropriation	1985 Administration request	1984[a]	1983	1982	% change 1984–85[b]
Space flight, control, and data communications	**$3601.8**	**$3600.3**	**$3775.3**	**$3633.0**	**$2269.5**	**−5%**
Conduct of R&D	**2433.4**	**2399.7**	**2028.2**	**1902.5**	**2562.6**	**20**
Physics and astronomy	680.2	677.2	567.6	470.3	322.4	20
Space transportation systems	367.4	361.4	431.7	415.5	1271.8	−15
Space applications	384.1	344.1	291.0	347.7	324.3	32
Aeronautical research and technology	352.0	342.0	302.3	280.0	264.8	16
Planetary exploration	293.9	286.9	217.4	186.4	210.0	35
Space research and technology	154.0	150.0	137.0	124.5	111.0	12
Space station	150.0	150.0	—	—	—	—
Life sciences	63.3	63.3	58.0	55.7	39.5	9
Tracking and data acquisition	15.3	15.3	14.2	13.4	10.8	8
Technology utilization	9.5	9.5	9.0	9.0	8.0	6
General reduction	−37.5	—	—	—	—	—
Research and program management	**1317.0**	**1331.0**	**1258.5**	**1197.3**	**1109.2**	**5**
Facilities	**150.0**	**150.0**	**160.0**	**155.5**	**78.7**	**−6**
TOTAL	**$7502.2**	**$7481.0**	**$7222.0**	**$6888.3**	**$6020.0**	**4%**

a Estimate. b Based on Congressional appropriation. **Note:** Fiscal years ending Sept. 30.

DEFENSE R&D BUDGET: Another hefty boost despite cutbacks by Congress

$ Millions	1985 Congressional authorization[a]	1985 Administration request	1984[b]	1983	1982	% change 1984–85[c]
Air Force	$13,280.8	$14,401.9	$12,220.1	$10,591.2	$ 8,659.6	9%
Navy	9,161.2	9,833.6	7,571.7	6,063.3	5,844.4	21
Army	4,574.3	4,987.7	4,259.7	3,875.3	3,609.5	7
Defense agencies	4,347.5	4,708.3	2,767.4	2,153.2	1,745.6	57
Director, test and evaluation	60.5	62.0	49.0	55.0	52.0	23
TOTAL	**$31,424.3**	**$33,993.5**	**$26,867.9**	**$22,738.0**	**$19,911.1**	**17%**

a C&EN estimate based on House and Senate passage. b Estimate. c Based on estimated Congressional authorization. **Note:** Fiscal years ending Sept. 30.

NIH BUDGET: Research on aging sets pace in a generally strong, broad increase

$ Millions	1985 Congressional appropriation[a]	1985 Administration request	1984[b]	1983	1982	% change 1984–85[c]
National Institutes	**$4743.5**	**$4219.2**	**$4120.6**	**$3705.5**	**$3392.0**	**15%**
Cancer	1187.1	1101.1	1077.3	987.6	943.0	10
Heart, Lung & Blood	807.2	718.9	703.2	624.3	559.6	15
Arthritis, Diabetes & Digestive & Kidney Disease	545.6	475.3	462.5	413.5	368.2	18
General Medical Science	495.2	423.8	415.6	369.5	355.4	19
Neurological & Communicative Disorders & Stroke	401.4	344.6	335.2	297.1	265.5	20
Allergy & Infectious Diseases	372.5	325.4	314.1	279.1	235.8	18
Child Health & Human Development	312.1	280.1	275.2	254.3	226.2	13
Environmental Health Sciences	191.9	183.7	179.8	164.9	154.1	7
Eye	187.2	157.8	154.7	141.9	130.4	21
Aging	144.8	117.4	114.9	94.0	81.8	26
Dental Research	98.5	91.1	88.1	79.3	72.0	12
Research Resources	**303.5**	**245.7**	**242.6**	**213.9**	**184.1**	**25**
National Library of Medicine	**53.5**	**51.3**	**49.6**	**51.9**	**44.8**	**8**
Office of the director	**29.1**	**27.5**	**26.7**	**24.7**	**23.6**	**9**
Research facilities	**21.7**	**11.1**	**25.0**	**17.5**	**9.9**	**−13**
John E. Fogarty Center	**11.9**	**11.4**	**11.3**	**10.1**	**9.2**	**5**
TOTAL	**$5163.2**	**$4566.2**	**$4475.8**	**$4023.6**	**$3663.6**	**15%**

a Based on minimal action to date. b Estimate. c Based on estimated Congressional appropriation. **Note:** Fiscal years ending Sept. 30.

BASIC RESEARCH: More than half of chemistry's support is from NSF and Energy Department

Department or agency	Federal obligations ($ millions)									
	1984[a]		1983[a]		1982		1981		1980	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 42.8	$ 40.8	$ 40.2	$ 38.3	$ 36.2	$ 34.5	$ 33.7	$ 31.8	$ 25.8	$ 24.0
Agricultural Research Service	36.7	35.3	33.7	32.5	30.0	28.9	27.7	26.5	20.8[b]	19.6[b]
Cooperative State Research Service	3.7	3.7	4.0	4.0	3.8	3.8	3.4	3.4	3.0[c]	3.0[c]
Commerce	13.6	4.2	14.7	4.3	13.7	4.2	12.6	2.9	11.3	2.2
National Bureau of Standards	13.3	3.9	14.5	4.1	13.7	4.2	12.6	2.9	11.0	2.1
Defense	217.8	60.9	195.0	52.3	188.7	51.5	194.9	43.5	167.1	35.7
Air Force	46.4	17.9	35.1	14.5	34.2	13.9	32.3	12.9	24.8	10.4
Army	63.4	20.2	55.5	17.7	59.6	20.0	49.5	14.5	46.0	12.7
Navy	106.2	22.7	102.1	20.1	93.1	17.7	79.7	15.9	72.0	12.3
Defense agencies[d]	1.8	0	2.3	0	1.8	0	33.4	0.2	24.3	0.2
Energy	672.9	87.6	600.5	76.1	530.8	75.5	480.2	70.0	432.1	62.1
Environmental Protection Agency	1.5	1.2	2.0	1.7	3.8	3.5	2.9	2.9	2.3	2.3
Health & Human Services	61.4	55.6	58.8	53.2	53.2	48.0	53.2	48.0	53.7	47.4
National Institutes of Health	60.2	54.4	58.6	53.0	52.9	47.7	52.8	47.6	53.0	46.6
Interior	9.7	2.4	8.3	2.0	8.1	2.5	10.1	6.8	7.5	5.3
Geological Survey	3.2	2.4	2.6	1.8	2.8	1.9	3.0	2.0	2.6	1.7
National Aeronautics & Space Administration	351.9	5.3	337.0	5.5	280.6	5.2	268.9	6.6	309.0	5.2
National Science Foundation	346.5	105.7	287.4	88.5	266.6	83.3	254.8	81.5	198.6	68.4
Tennessee Valley Authority	3.7	3.7	3.4	3.4	3.0	3.0	3.1	3.1	3.1	3.1
Others	9.7	0.3	9.5	0.4	9.1	0.8	10.5	1.1	10.1	1.2
TOTAL	$1731.5	$367.7	$1556.8	$325.7	$1393.8	$312.0	$1324.9	$298.2	$1220.6	$256.9

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. d Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

APPLIED RESEARCH: Chemistry receives 11% of funding for physical sciences this year

Department or agency	Federal obligations ($ millions)									
	1984[a]		1983[a]		1982		1981		1980	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 26.4	$ 24.4	$ 27.8	$ 25.7	$ 26.0	$ 24.0	$ 25.0	$ 22.7	$ 26.9	$ 24.9
Agricultural Research Service	17.9	16.6	18.6	17.2	17.1	15.8	16.2	14.6	20.0[b]	17.8[b]
Cooperative State Research Service	6.3	6.3	6.9	6.9	6.4	6.4	5.8	5.8	5.4[c]	5.4[c]
Commerce	33.5	9.0	35.2	9.5	32.6	8.8	30.5	8.9	27.4	7.3
National Bureau of Standards	25.4	7.5	25.9	7.9	25.4	7.3	24.4	7.5	21.3	6.0
Defense	710.9	75.0	565.0	62.4	500.0	66.6	335.2	47.2	243.4	42.5
Air Force	55.2	14.6	53.0	13.9	50.5	13.3	49.7	14.3	41.5	12.5
Army	76.7	43.9	76.1	35.8	83.2	41.4	58.6	24.6	54.3	24.2
Navy	145.5	16.5	128.8	12.8	128.7	11.7	98.5	8.1	59.0	5.3
Defense agencies[d]	433.5	0	307.2	0	237.6	0.3	128.4	0.3	88.6	0.6
Energy	578.3	13.2	576.9	12.8	482.8	29.9	390.2	13.7	360.0	22.2
Environmental Protection Agency	11.7	10.7	13.8	12.8	16.6	15.3	66.4	66.4	69.3	68.4
Health & Human Services	20.5	17.9	19.1	16.6	17.6	15.3	25.1	22.1	26.1	22.5
National Institutes of Health	19.0	16.4	18.7	16.2	17.2	14.9	24.8	21.8	25.4	21.8
Interior	10.7	4.4	10.7	4.4	10.2	3.7	7.3	5.3	6.4	4.4
Geological Survey	5.3	4.4	4.7	3.8	4.0	3.2	5.0	4.0	3.7	2.9
National Aeronautics & Space Administration	37.2	1.7	33.9	1.6	8.9	1.0	11.3	1.1	12.2	1.5
National Science Foundation	7.1	3.0	6.9	3.0	6.0	2.8	2.2	0.9	4.7	2.3
Others	11.1	2.0	5.7	2.5	5.8	1.8	2.4	0.4	3.5	1.6
TOTAL	$1447.4	$161.3	$1295.0	$151.3	$1106.5	$169.2	$895.6	$188.7	$780.0	$197.6

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. d Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

OBLIGATIONS FOR ENGINEERING RESEARCH: Only about 3% goes for chem engineering

Department or agency	Federal obligations ($ millions)									
	1984[a]		1983[a]		1982		1981		1980	
	Engineering	Chemical engineering	Engineering	Chemical engineering	Engineering	Chemical engineering	Engineering	Chemical engineering	Engineering	Chemical engineering
Agriculture	$ 53.0	$ 6.0	$ 53.9	$ 6.0	$ 51.2	$ 5.8	$ 50.7	$ 5.3	$ 46.5	$ 4.5
Agricultural Research Service	33.1	3.3	33.0	3.2	30.0	2.9	30.0	2.7	28.5[b]	2.4[b]
Cooperative State Research Service	6.9	0	7.5	0	6.9	0	6.3	0	5.8[c]	0[c]
Commerce	29.0	1.3	37.5	1.1	32.0	2.0	28.5	1.0	40.6	0.7
National Bureau of Standards	23.3	1.3	30.3	1.1	23.8	2.0	19.7	1.0	18.9	0.7
Defense	1618.1	42.7	1481.1	42.7	1473.3	39.0	1324.1	31.1	1165.2	24.0
Air Force	433.7	3.0	398.0	2.8	387.3	2.9	388.3	2.6	343.5	2.6
Army	353.3	26.9	292.8	27.3	297.2	24.4	266.0	18.3	231.3	10.7
Navy	421.3	12.3	389.9	12.1	378.0	11.6	356.4	9.9	314.2	10.4
Defense agencies[d]	409.8	0.4	400.4	0.5	410.8	0.2	313.4	0.2	276.2	0.4
Energy	309.5	17.9	477.0	50.1	420.8	1.1	270.2	30.6	193.1	14.4
Environmental Protection Agency	27.8	10.6	46.9	16.5	76.4	26.0	77.2	55.8	85.3	32.0
Health & Human Services	46.6	0	45.6	0	41.4	0	48.8	0	43.2	0
National Institutes of Health	46.6	0	45.6	0	41.4	0	43.6	0	43.1	0
Interior	64.1	3.7	98.3	1.1	87.1	1.4	68.5	3.4	79.1	4.2
Geological Survey	3.9	3.2	5.9	0	8.2	0.2	7.0	0	8.9	0
National Aeronautics & Space Administration	870.1	0.4	819.3	0.4	771.7	0.4	780.7	0.3	799.6	0.2
National Science Foundation	167.6	24.9	139.5	20.5	129.9	18.8	121.0	19.1	106.8	15.0
Tennessee Valley Authority	4.2	0	7.4	0	5.1	0	7.6	0	8.9	0
Others	296.9	0.4	295.0	0.5	297.6	0.6	294.2	1.0	261.7	1.3
TOTAL	$3486.9	$107.9	$3501.5	$138.9	$3386.5	$95.1	$3071.5	$147.6	$2830.1	$96.3

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. d Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

UNIVERSITY RESEARCH: More than 70% of federal money funneled to life, physical sciences

Federal obligations, $ millions	1984[a]	1983[a]	1982	1981	1980	1979	1978	Annual change 1983–84	Annual change 1978–84
Engineering	$ 446.7	$ 389.3	$ 361.5	$ 365.3	$ 323.7	$ 269.6	$ 240.9	15%	11%
Chemical	25.9	21.5	19.4	21.9	20.3	19.2	24.5	20	1
Metallurgy and materials	94.6	80.6	75.3	69.5	57.3	52.3	49.2	17	12
Environmental sciences	332.3	294.8	274.7	280.3	297.0	275.5	226.5	13	7
Life sciences	2506.4	2422.1	2205.0	2117.2	1984.7	1796.0	1605.2	3	8
Mathematics and computer sciences	204.2	166.2	139.7	121.4	94.6	87.5	79.5	23	17
Physical sciences	680.1	604.2	559.1	525.2	461.0	402.8	366.6	13	11
Chemistry	220.5	204.8	189.6	193.5	159.5	140.1	123.5	8	10
Physics	386.0	338.5	306.0	274.5	246.1	214.7	198.7	14	12
Other sciences	301.3	299.0	255.7	297.5	302.7	285.6	253.0	1	3
TOTAL	$4471.0	$4175.6	$3795.7	$3706.9	$3463.6	$3117.0	$2771.7	7%	8%

a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

UNIVERSITY BASIC RESEARCH: Federal funding devoted to chemistry rises

Federal obligations, $ millions	1984[a]	1983[a]	1982	1981	1980	1979	1978	Annual change 1983–84	Annual change 1978–84
Engineering	$ 333.4	$ 277.9	$ 259.0	$ 237.3	$ 208.4	$ 164.0	$ 151.5	20%	14%
Chemical	22.8	18.6	16.8	19.8	16.9	12.5	9.3	23	16
Metallurgy and materials	87.4	74.3	69.6	62.6	51.9	47.6	43.4	18	12
Environmental sciences	300.8	273.2	256.0	241.6	255.3	229.9	191.8	10	8
Life sciences	1728.0	1649.3	1483.7	1314.6	1219.5	1140.1	926.9	5	11
Mathematics and computer sciences	171.4	139.8	118.8	102.6	79.8	69.0	65.3	23	17
Physical sciences	579.1	496.0	455.3	434.7	375.9	323.3	299.5	17	12
Chemistry	197.6	176.8	165.3	164.7	136.1	114.3	102.2	12	12
Physics	314.8	267.5	238.6	222.4	194.3	166.2	157.1	18	12
Other sciences	159.8	151.9	120.5	148.2	152.4	125.4	103.1	5	8
TOTAL	$3272.5	$2988.1	$2693.3	$2479.0	$2291.3	$2051.7	$1738.1	10%	11%

a Estimated. **Note:** Fiscal years. **Source.** National Science Foundation

SCIENTISTS AND ENGINEERS BY AGENCY: Most chemists work for defense or health

Department or agency	Physical scientists	Chemists	Physicists	Engineers	Chemical engineers	Other scientists	Total scientists and engineers
Agriculture	1,546	902	28	3,162	56	25,554	30,262
Commerce	3,741	320	540	748	29	4,225	8,714
Defense	9,057	2097	3188	63,926	960	34,665	107,648
Air Force	1,115	312	468	11,287	63	5,842	18,244
Army	3,216	921	807	22,794	530	12,321	38,331
Navy	3,982	762	1886	28,400	359	9,992	42,374
Others	744	102	27	1,445	8	6,510	8,699
Energy	761	202	117	2,706	150	874	4,341
Environmental Protection Agency	1,574	558	15	1,561	128	1,142	4,277
Health & Human Services	2,219	2063	88	442	18	7,034	9,695
Interior	4,874	427	52	3,172	85	7,769	15,815
National Aeronautics & Space Administration	1,231	64	257	9,060	39	935	11,226
Transportation	99	25	8	4,483	13	1,529	6,111
Veterans Administration	635	557	41	1,107	0	3,354	5,096
Others	1,317	461	48	3,883	42	10,506	15,706
TOTAL	27,054	7676	4382	94,250	1520	97,587	218,891

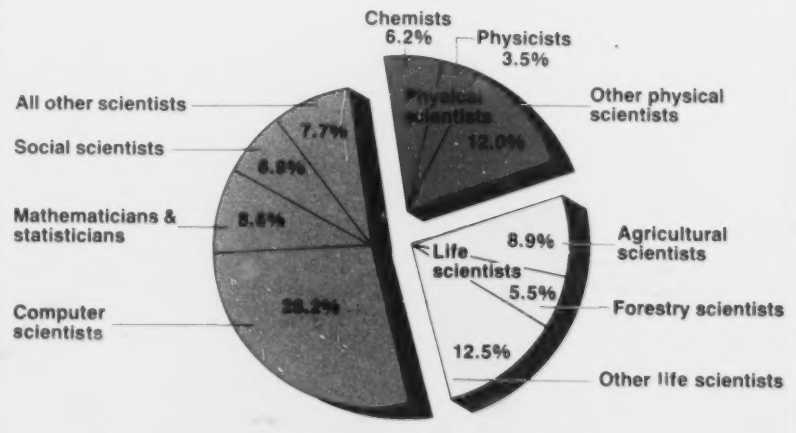
Note: Data as of October 1983. **Source:** National Science Foundation

FEDERAL SCIENTISTS AND ENGINEERS: Number of chemists has dwindled in past four years

Thousands	1983	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Physical scientists	27.1	27.4	27.6	27.6	27.5	27.1	27.1	26.7	26.3	26.4	27.4
Chemists	7.7	7.9	8.1	8.1	8.3	8.0	8.1	8.0	7.8	8.0	8.4
Physicists	4.4	4.5	4.6	4.9	5.0	5.1	5.3	5.4	5.5	5.6	5.8
Engineers	94.3	90.9	89.6	88.8	89.2	87.8	87.0	86.6	82.5	84.3	87.0
Chemical	1.5	1.4	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.6
Computer scientists	35.2	na	na	na	na	na	na	na	na	na	na
Other scientists	62.3	59.3	60.8	58.3	57.2	54.3	51.6	50.6	48.8	48.4	50.1
TOTAL	218.9	177.5	178.0	174.7	173.9	169.2	165.7	163.9	157.6	159.1	164.5

Note. As of October of each year. No data for 1982. **na** = not available. **Source:** National Science Foundation

Chemists constitute about 6% of all federal scientists



1983 total federal scientists = 124,641[a]

a As of October 1983. **Source:** National Science Foundation

Growth slows a bit for industrial R&D

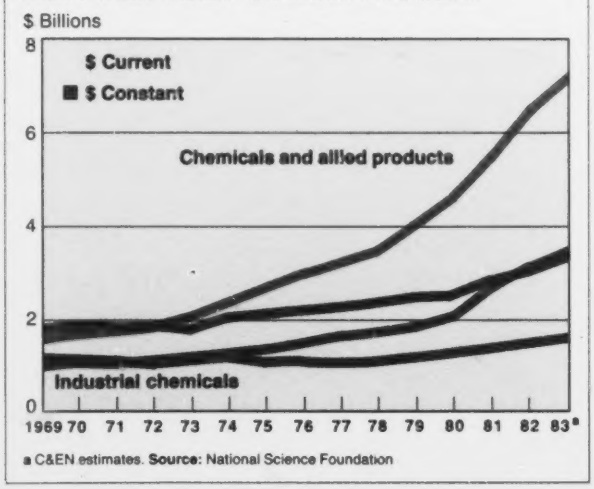
In the wake of recession, spending by industrial companies expanded last year at the slowest rate in the past eight years but did well, nonetheless, in real terms

TOTAL FUNDS FOR INDUSTRIAL R&D: Spending by chemical industry has doubled since 1978

$ Millions	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Chemicals and allied products	$ 7,400[a]	$ 6,588	$ 5,625	$ 4,636	$ 4,038	$ 3,580	$ 3,202	$ 3,017	$ 2,727	$ 2,450	$ 2,116	12%	13%
Industrial chemicals	3,485[a]	3,191	2,802	2,197	1,962	1,798	1,668	1,524	1,391	1,299	1,119	9	12
Drugs	3,915[a]	3,397	2,823	1,777	1,517	1,308	1,117	1,091	981	807	698	15	15
Other chemicals				662	559	474	417	401	354	344	299		
Other industries	**57,200[a]**	**52,372**	**46,185**	**39,669**	**34,188**	**29,724**	**26,623**	**23,980**	**21,460**	**20,437**	**19,133**	**9**	**12**
TOTAL	**$64,600**	**$58,960**	**$51,810**	**$44,505**	**$38,226**	**$33,304**	**$29,825**	**$26,997**	**$24,187**	**$22,887**	**$21,249**	**10%**	**12%**

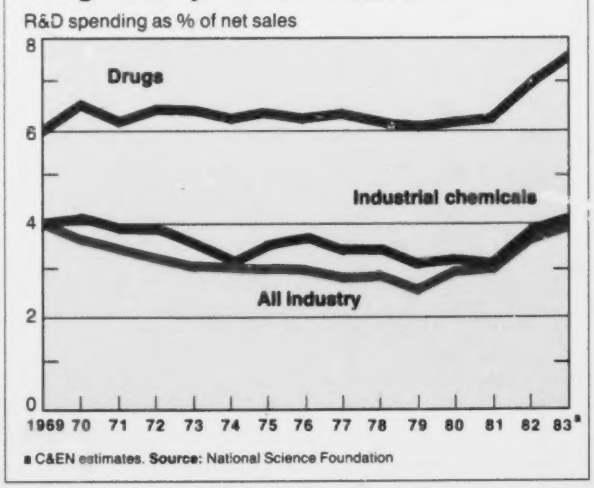
a C&EN estimates. **Source:** National Science Foundation

Increases in chemical firms' R&D budgets more than match inflation's inroads



a C&EN estimates. **Source:** National Science Foundation

Industry's spending for R&D has been rising recently relative to sales



a C&EN estimates. **Source:** National Science Foundation

FEDERAL FUNDS FOR INDUSTRIAL R&D: Chemical industry's share is only 2% of total

$ Millions	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Chemicals and allied products	**$ 475[a]**	**$ 433**	**$ 421**	**$ 372**	**$ 346**	**$ 330**	**$ 295**	**$ 266**	**$ 236**	**$ 214**	**$ 203**	**10%**	**9%**
Industrial chemicals	460[a]	422	409	341	345	325	281	249	218	194	183	9	10
Drugs and other chemicals	15[a]	11	12	31	1	5	14	17	18	20	20	36	−3
Other industries	**20,425[a]**	**18,626**	**15,961**	**13,657**	**12,172**	**10,859**	**10,190**	**9295**	**8369**	**8006**	**7942**	**10**	**10**
TOTAL	**$28,900**	**$19,059**	**$16,382**	**$14,025**	**$12,518**	**$11,189**	**$10,485**	**$9561**	**$8605**	**$8220**	**$8145**	**10%**	**10%**

a C&EN estimates. **Source:** National Science Foundation

COMPANY FUNDS FOR INDUSTRIAL R&D: Drug producers' budgets rise sharply

$ Millions	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Chemicals and allied products	**$ 6,925[a]**	**$ 6,155**	**$ 5,205**	**$ 4,264**	**$ 3,692**	**$ 3,250**	**$ 2,907**	**$ 2,751**	**$ 2,490**	**$ 2,236**	**$ 1,919**	**13%**	**14%**
Industrial chemicals	3,025[a]	2,769	2,393	1,856	1,617	1,473	1,387	1,275	1,173	1,105	936	9	12
Drugs	2,950[a]	2,531	2,065	1,755	2,075	1,777	1,520	1,476	1,317	1,131	977	17	15
Other chemicals	950[a]	855	747	653								11	
Other industries	**$36,775[a]**	**33,746**	**30,223**	**26,212**	**22,016**	**18,865**	**16,433**	**14,685**	**13,092**	**12,431**	**11,191**	**9**	**13**
TOTAL	**$43,700**	**$39,901**	**$35,428**	**$30,476**	**$25,708**	**$22,115**	**$19,340**	**$17,436**	**$15,582**	**$14,667**	**$13,104**	**10%**	**13%**

a C&EN estimates. **Source:** National Science Foundation

R&D BY U.S. COMPANIES ABROAD: Growth slows for spending outside U.S.

$ Millions	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1982–83	Annual change 1974–83
Chemicals and allied products	**$ 725**	**$ 713**	**$ 715**	**$ 603**	**$ 500**	**$ 395**	**$ 332**	**$ 312**	**$ 269**	**$ 208**	**2%**	**15%**
Industrial and other chemicals	325	313	287	245	199	151	133	108	85	82	4	17
Drugs	400	400	428	357	301	244	199	204	184	126	0	14
Other industries	**2525**	**2400**	**2679**	**2562**	**2254**	**1814**	**1545**	**1347**	**1185**	**1092**	**5**	**10**
TOTAL	**$3250**	**$3113**	**$3393**	**$3165**	**$2754**	**$2209**	**$1877**	**$1659**	**$1454**	**$1300**	**4%**	**11%**

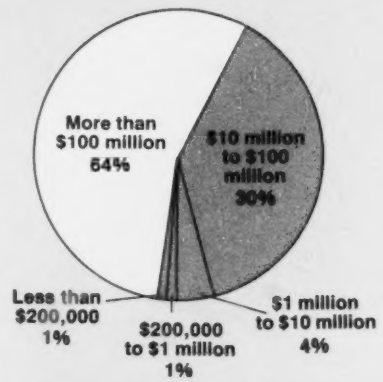
a C&EN estimates. **Source:** National Science Foundation

CHEMICAL R&D SPENDING: Increases during past two years are less than those in early 1980s

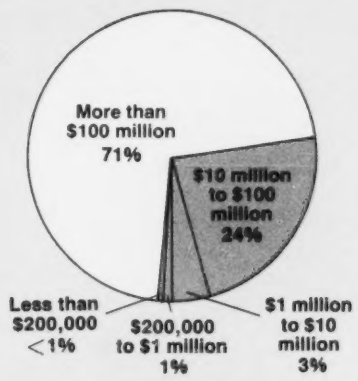
$ Millions	1984[a]	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974
Air Products	$ 42	$ 40	$ 37	$ 32	$ 30	$ 24	$ 23	$ 24	$ 19	$ 16	$ 11
American Cyanamid	235	215	190	172	148	130	108	96	83	73	64
Celanese	100	88	102	104	94	92	83	77	70	64	58
Dow Chemical	508	492	460	404	314	269	232	203	188	167	149
Du Pont	945	875	775	647	591	509	461	367	353	336	344
Ethyl	39	39	39	37	34	29	25	28	25	19	25
W. R. Grace	82	71	62	55	45	42	37	32	28	30	32
Hercules	66	74	74	65	57	50	43	40	37	32	32
Lubrizol	38	37	36	33	28	23	21	19	17	17	15
Monsanto	385	290	264	233	208	161	136	132	114	116	87
Olin	55	51	47	39	31	26	25	25	23	24	19
PPG Industries	125	127	127	119	103	83	70	61	56	50	47
Rohm & Haas	100	100	92	77	67	54	49	45	43	45	39
Stauffer Chemical	66	63	57	49	44	35	32	32	28	23	20
Union Carbide	250	245	240	207	166	161	156	156	143	120	94
TOTAL	**$3036**	**$2807**	**$2602**	**$2273**	**$1960**	**$1688**	**$1501**	**$1337**	**$1227**	**$1132**	**$1036**
ANNUAL CHANGE	**8%**	**8%**	**14%**	**16%**	**16%**	**12%**	**12%**	**9%**	**8%**	**9%**	**21%**

a Planned. **Source:** Company data

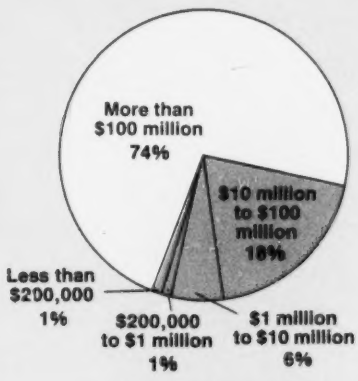
Firms with R&D budgets of more than $100 million do more than 60% of R&D



Total 1982 chemicals and allied products R&D funds = $6.6 billion



Total 1982 industrial chemicals R&D funds = $3.2 billion



Total 1982 industry R&D funds = $59.0 billion

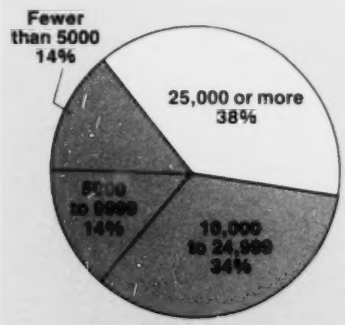
Note: Ranges indicate size of company's 1982 R&D program. Source: National Science Foundation

R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: Drug firms' increase boosts chemical total

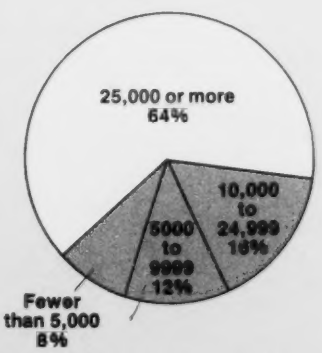
Thousands[a]	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973
Chemicals and allied products	67.1	61.6	54.7	51.4	50.0	48.3	46.4	44.4	45.2	41.8	40.9
Industrial chemicals	26.4	25.9	21.6	20.9	21.4	21.3	20.6	20.1	21.1	19.1	19.1
Drugs	30.0	25.6	23.3	21.6	20.9	19.5	17.8	16.6	15.6	14.0	13.0
Other chemicals	10.7	10.1	9.8	8.9	7.9	7.5	8.0	7.8	8.5	8.7	8.8
Other industries	468.5	448.2	433.1	399.2	373.9	356.1	336.4	320.0	318.1	318.2	316.8
TOTAL	535.6	509.8	487.8	450.6	423.9	404.4	382.8	364.4	363.3	360.0	357.7

a Full-time equivalent. Note: Data as of January of each year. Source: National Science Foundation

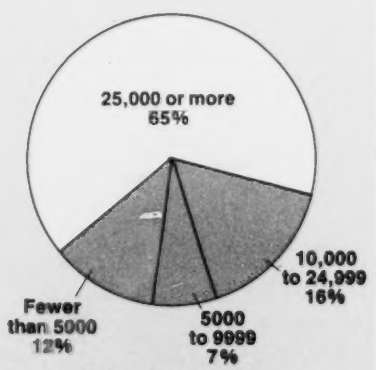
Companies with the most employees account for the greatest share of R&D outlays



1982 chemicals and allied products R&D funds = $6.2 billion[a]



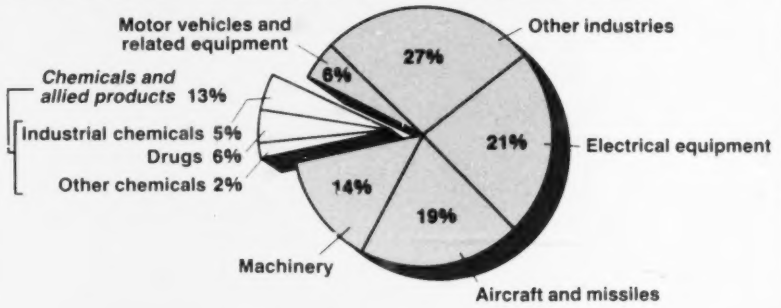
1982 industrial chemicals R&D funds = $2.8 billion[a]



1982 industry R&D funds = $39.9 billion[a]

a Excludes federal funding. Note: Ranges indicate company's number of employees in 1982. Source: National Science Foundation

Chemical and allied products industry employs 13% of all scientists and engineers doing industrial R&D



1983 total industrial R&D scientists and engineers[a] = 535,600

a Full-time equivalent. **Source:** National Science Foundation

R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: Chemical firms above average

	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971
Chemicals and allied products	**50**	**44**	**42**	**42**	**43**	**42**	**40**	**41**	**40**	**39**	**39**	**41**
Industrial chemicals	43	37	36	36	38	38	36	38	37	36	34	35
Drugs	76	66	60	62	65	62	64	59	57	57	60	65
Other chemicals	35	33	30	27	27	29	28	29	30	29	31	31
All industry	**32**	**29**	**27**	**27**	**27**	**27**	**27**	**26**	**25**	**24**	**24**	**26**

Source: National Science Foundation

COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: Average doubled since 1972

$ Thousands	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Chemical and allied products	**$102.4**	**$ 96.6**	**$ 87.4**	**$79.6**	**$72.8**	**$67.6**	**$66.5**	**$60.9**	**$56.3**	**$51.1**	**$47.1**
Industrial chemicals	122.0	118.0	103.4	92.8	84.2	79.6	74.7	67.5	63.5	58.6	54.0
Drugs	a	a	79.2	71.4	64.8	59.9	63.4	60.9	54.3	51.5	46.5
Other chemicals	a	a	66.5	66.5	61.6	53.8	50.8	43.2	45.3	34.0	33.4
All industry	**$112.8**	**$103.9**	**$ 94.9**	**$87.4**	**$80.4**	**$75.8**	**$72.2**	**$66.5**	**$63.3**	**$59.2**	**$55.3**

a Not separately available but included in chemicals and allied products. **Source:** National Science Foundation

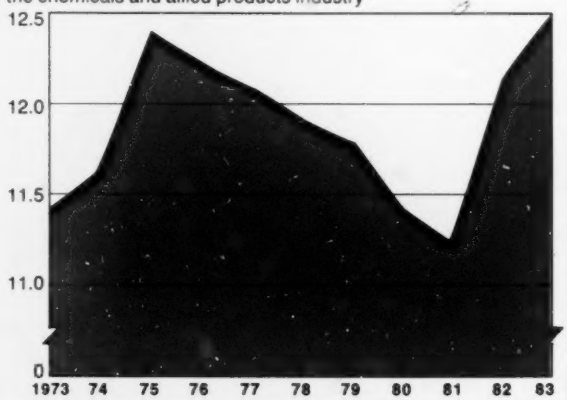
CHEMISTS IN INDUSTRY: Nearly 40% of Ph.D.s work for chemical firms

	% of industrial chemists			
Industry	All chemists	B.S.	M.S.	Ph.D.
Chemical	34%	29%	31%	39%
Pharmaceutical[a]	18	16	19	18
Petroleum	6	5	5	7
Coatings	5	7	6	3
Food	4	4	4	4
Metals and minerals	3	4	3	2
Rubber	2	3	3	2
Other manufacturing	21	22	22	21
Nonmanufacturing	7	10	8	5

a Includes personal care products. **Source:** 1984 ACS survey

Share of R&D scientists and engineers in chemical industry climbs to 10-year peak

% of total industrial R&D scientists and engineers in the chemicals and allied products industry[a]



a Full-time equivalent. **Source:** National Science Foundation

Growth in federal support slackens

Government funds pay for nearly two thirds of R&D on U.S. campuses, but industry's still small share is expanding fast

CHARACTER OF UNIVERSITY R&D SPENDING: Two thirds goes to basic research

$ Millions	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1983–82	Annual change 1973–83
Basic research	$5135	$4851	$4576	$4020	$3612	$3176	$2800	$2549	$2410	$2154	$2053	6%	10%
Applied research	2095	1995	1865	1691	1465	1213	1067	1015	851	736	713	5	11
Development	445	415	377	343	284	236	200	164	148	133	118	7	14
TOTAL	**$7675**	**$7261**	**$6818**	**$6060**	**$5361**	**$4625**	**$4067**	**$3728**	**$3409**	**$3023**	**$2884**	**6%**	**10%**

a Estimated. **Source:** National Science Foundation

SOURCE OF UNIVERSITY R&D FUNDS: Industry's share is small but growing fastest

$ Millions	1983[a]	1982	1981	1980	1979	1978[b]	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Federal government	$4900	$4749	$4559	$4094	$3595	$3059	$2726	$2512	$2288	$2032	$1985	3%	9%
State and local governments	650	586	540	494	470	414	374	364	332	307	295	11	8
Industry	375	326	288	236	193	170	139	123	113	96	94	15	16
Institutional funds	1210	1098	983	829	730	623	514	446	417	370	318	10	14
Other sources	540	503	448	409	374	359	314	285	259	218	202	7	10
TOTAL	**$7675**	**$7261**	**$6818**	**$6060**	**$5631**	**$4625**	**$4067**	**$3729**	**$3409**	**$3023**	**$2884**	**6%**	**10%**

a Estimated. b Estimated, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal year. **Source:** National Science Foundation

FIELDS OF UNIVERSITY R&D SPENDING: Chemistry shows better than average growth

$ Millions	1983[a]	1982	1981	1980	1979	1978[b]	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Physical sciences	**$1880**	**$ 822.8**	**$ 766.5**	**$ 677.6**	**$ 601.9**	**$ 496.4**	**$ 423.5**	**$ 379.4**	**$ 350.3**	**$ 333.5**	**$ 328.3**	**7%**	**10%**
Chemistry	335	311.5	285.5	244.5	206.4	183.1	159.4	140.1	120.7	115.8	113.7	8	11
Physics	385	363.3	356.9	322.1	292.0	235.1	201.7	183.1	173.5	169.3	167.0	6	9
Engineering	**1080**	**1024.5**	**960.0**	**864.0**	**768.4**	**601.1**	**498.5**	**431.7**	**380.9**	**346.9**	**333.1**	**5**	**12**
Total R&D spending	**$7675**	**$7260.6**	**$6818.3**	**$6060.1**	**$5361.4**	**$4624.7**	**$4067.0**	**$3729.0**	**$3408.7**	**$3022.6**	**$2884.0**	**6%**	**10%**

a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Increases were modest last year

$ Millions	1983[a]	1982	1981	1980	1979	1978[b]	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Physical sciences	**$ 675**	**$ 649.7**	**$618.6**	**$ 554.5**	**$ 490.7**	**$ 392.3**	**$ 338.8**	**$ 305.4**	**$ 285.0**	**$ 270.2**	**$ 268.4**	**4%**	**10%**
Chemistry	245	231.6	216.6	189.3	156.5	138.0	121.5	107.9	92.7	88.7	86.6	6	11
Physics	310	305.9	308.5	279.7	252.5	199.2	171.9	156.1	149.9	146.5	145.4	1	8
Engineering	**710**	**697.2**	**661.6**	**594.6**	**526.4**	**407.5**	**336.7**	**290.5**	**259.4**	**239.3**	**238.1**	**2**	**12**
Total R&D spending	**$4900**	**$4749.3**	**$4559.0**	**$4093.6**	**$3595.3**	**$3058.7**	**$2726.1**	**$2511.9**	**$2288.1**	**$2032.2**	**$1985.4**	**3%**	**9%**

a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. **Note.** Data for institutional fiscal years. **Source:** National Science Foundation

TOP 12 UNIVERSITIES IN R&D SPENDING: Johns Hopkins, MIT lead in science and engineering

$ Millions, fiscal 1982	Physical sciences	Chemistry[a]	Engineering	Environmental sciences	Life sciences	Math and computer sciences	Other sciences[b]	Total
Johns Hopkins U	$53.9	$4.7	$76.4	$29.3	$73.8	$46.3	$10.2	**$289.9**
Massachusetts Inst. of Technology	49.1	9.8	84.1	12.0	26.2	8.8	12.3	**192.5**
U of Wisconsin, Madison	14.5	4.6	15.9	13.8	85.7	5.9	21.8	**157.6**
Stanford U	23.1	6.6	45.1	3.2	60.4	10.2	5.9	**147.9**
U of Minnesota	9.1	4.3	12.8	2.6	110.7	1.8	9.5	**146.5**
Cornell U	23.8[c]	6.2[c]	22.6[c]	4.1[c]	83.3[c]	2.6[c]	9.4[c]	**145.8**
U of California, San Diego	17.8	3.9	1.0	61.3	54.0	1.9	2.9	**138.9**
U of Washington	8.1	2.3	7.6	15.3	80.2	2.0	19.9[c]	**133.1**
U of Michigan	8.0	2.1	17.4	6.0	58.7	2.4	27.5	**120.0**
Columbia U, main division	11.6	4.7	6.4	22.3	68.2	0.8	6.3	**115.6**
Harvard U	14.2[c]	5.5[c]	1.7[c]	6.6[c]	81.5[c]	1.5[c]	9.3[c]	**114.8[c]**
U of Pennsylvania	9.2	3.1	6.6	0.7	72.2	3.1	21.0	**112.8**

a Included in physical sciences. b Includes social sciences, psychology, and other sciences not listed separately. c Estimated. **Source:** National Science Foundation

TOP 12 UNIVERSITY R&D CENTERS:[a] Half of funding spent on physical sciences

$ Millions, fiscal 1981	Physical sciences	Engineering	Environmental sciences	Math and computer sciences	Total[b]
Los Alamos Natl Lab	$237.7	$159.6	$10.4	$ 43.3	**$497.3**
Lawrence Livermore Natl Lab	377.7	47.3	30.2	11.5	**487.4**
Jet Propulsion Lab	70.0	158.8	23.6	140.7	**393.1**
Argonne Natl Lab	65.9	113.9	34.9	2.8	**230.5**
Brookhaven Natl Lab	106.6	30.1	9.0	0.4	**168.4**
Lincoln Lab	30.0	108.7	0	15.9	**154.8**
Lawrence Berkeley Lab	76.0	12.1	12.9	4.0	**128.2**
Plasma Physics Lab	115.6	0	0	0	**115.6**
Fermi Natl Accelerator Lab	108.7	0	0	0	**108.7**
Stanford Linear Accelerator Center	70.7	0	0	0	**70.7**
National Center for Atmospheric Research	3.9	0	35.2	0	**39.1**
Ames Laboratory	12.4	5.5	0	0.5	**18.5**

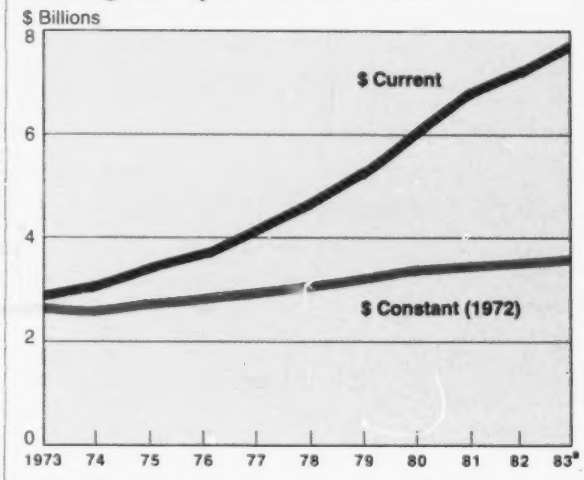
a Data for university-administered federally funded R&D centers. b Includes life sciences and other sciences not listed separately. **Source:** National Science Foundation

ACADEMIC SCIENTISTS AND ENGINEERS: Little change for chemists since 1981

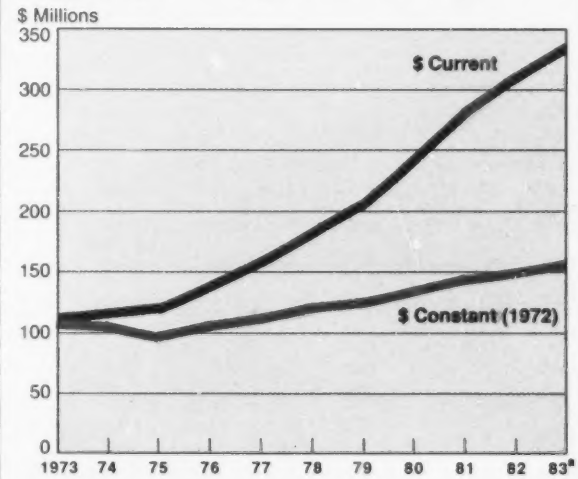
Thousands of scientists and engineers[a]	1983	1982	1981	1980	1978	1977	1976
TOTAL							
Physical scientists	**34.7**	**34.5**	**34.1**	**33.6**	**32.8**	**32.1**	**31.4**
Chemists	18.2	18.0	18.1	17.6	17.7	17.1	16.6
Physicists	13.5	13.3	12.9	13.0	12.8	12.5	12.2
Engineers	**37.7**	**36.4**	**34.8**	**33.7**	**31.0**	**30.1**	**28.5**
Chemical	2.4	2.3	2.3	2.4	2.0	1.9	1.9
Other scientists	**286.4**	**278.4**	**265.6**	**257.0**	**243.9**	**235.7**	**228.4**
TOTAL	**358.8**	**349.3**	**334.5**	**324.2**	**307.8**	**297.9**	**288.3**
FULL TIME ONLY							
Physical scientists	**28.4**	**28.5**	**28.2**	**28.0**	**27.9**	**27.6**	**27.1**
Chemists	14.7	14.4	14.8	14.3	14.7	14.5	14.1
Physicists	11.4	11.4	11.0	11.3	11.3	11.1	10.8
Engineers	**28.8**	**28.0**	**27.0**	**26.5**	**24.7**	**24.1**	**22.9**
Chemical	2.0	1.9	1.9	1.9	1.7	1.7	1.6
Other scientists	**215.8**	**211.3**	**204.6**	**200.5**	**189.5**	**184.6**	**179.9**
TOTAL	**273.0**	**267.8**	**259.7**	**255.0**	**242.2**	**236.3**	**229.9**

a In January. **Note:** Data not available for 1979. **Source:** National Science Foundation

Spending for all academic R&D is barely holding steady in real terms . . .



. . . and chemical R&D spending also is struggling to keep pace with inflation



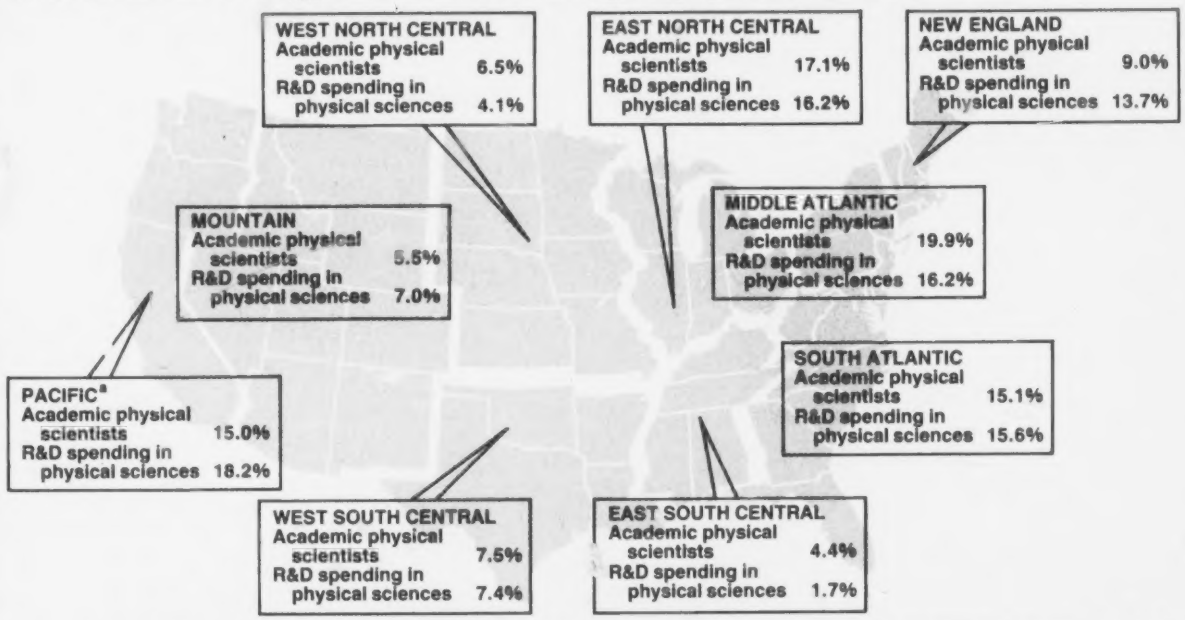
a C&EN estimate. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

SCHOOLS SPENDING MOST ON CHEMICAL R&D: Top 50 spent over 60% of total

$ Thousands	Total spending				Federally financed spending			
	1982	1981	1980	1979	1982	1981	1980	1979
1 Massachusetts Inst. of Technology	$ 9,792	$ 8,222	$ 6,764	$ 5,324	$ 9,096	$ 7,572	$ 6,311	$ 5,021
2 Stanford U	6,634	5,564	4,788	4,159	5,893	5,337	4,609	3,775
3 U of Illinois, Urbana	6,422	5,239	4,261	3,963	4,763	3,847	3,424	2,696
4 U of California, Berkeley	6,283	6,553	6,022	3,717	5,691	6,008	5,601	3,485
5 Cornell U	6,239[a]	4,618	3,808	3,414	5,437	4,602	3,404	3,087
6 California Inst. of Technology	6,136	6,901	6,328	5,297	5,809	6,196[a]	5,630	4,813
7 Harvard U	5,512[a]	6,123[a]	4,797[a]	4,283[a]	4,174	4,637	3,631	3,241
8 Indiana U	5,341	3,637	3,147	2,644	4,237	3,042	2,635	2,306
9 U of California, Los Angeles	5,187	4,420	4,159	3,573	4,978	4,127	4,017	3,379
10 U of Texas, Austin	4,843	4,779	3,970	3,373	2,781	3,017	2,564	2,282
Total, first 10 institutions	**62,389**	**56,056**	**48,044**	**39,747**	**52,859**	**47,845**	**41,826**	**34,085**
11 Johns Hopkins U	4,721	4,066	4,652	4,064[a]	3,800	3,881	4,444	3,968[a]
12 Columbia U, main division	4,700	3,564	4,437	3,531	4,365	3,471	4,054	3,202
13 U of Wisconsin, Madison	4,567	4,122	3,976	3,346	3,404	3,134	2,944	2,353
14 Texas A&M U	4,521	4,069	4,097	3,715	2,823	2,793	2,945	2,361
15 Purdue U	4,459	4,600	3,596	3,438	3,946	3,715	3,151	3,087
16 U of Chicago	4,396[a]	4,139[a]	3,958[a]	3,418[a]	3,716	3,719	3,558	3,039
17 U of Massachusetts, Amherst	4,364	3,230	1,889	2,621	2,773	2,067	1,632	1,921
18 U of Minnesota	4,297	4,260	2,642	2,162	3,377	2,494	2,143	1,624
19 U of Notre Dame	4,020	3,855	3,457	2,746	3,866	3,736	3,328	2,618
20 U of Maryland, College Park	4,009	3,109	2,766	1,907	3,068	2,418	2,292	1,628
Total, first 20 institutions	**106,443**	**95,070**	**83,514**	**70,695**	**87,997**	**80,275**	**72,317**	**59,886**
21 U of California, San Diego	3,894	4,430	4,425[a]	3,757[a]	3,506	3,933	4,375[a]	3,707[a]
22 Pennsylvania State U	3,564	3,413	2,973	2,303	3,222	2,773	2,527	1,989
23 U of Colorado	3,492	4,047	3,332	2,544	2,755	3,146	2,605	1,942
24 U of Utah	3,364	3,076	2,811	2,290	2,858	2,720	2,373	1,949
25 Georgia Inst. of Technology	3,327	3,660	3,655	3,577	1,800	2,030	2,118	2,110
26 U of Nebraska, Lincoln	3,217	2,175	2,289	1,745	1,995	1,757	1,909	983
27 U of Rochester	3,123	2,966	2,089	2,536	2,774	2,553	1,667	2,056
28 U of Pennsylvania	3,068	3,386	3,688	2,211	2,745	3,073	3,143	1,840
29 Princeton U	3,062	2,513	2,065	2,242	2,485	2,142	1,646	1,621
30 Northwestern U	3,026	2,995	2,367	1,851	2,711	2,813	2,221	1,671
Total, first 30 institutions	**139,580**	**127,731**	**113,208**	**95,751**	**114,848**	**107,215**	**96,901**	**79,754**
31 Rensselaer Polytech Inst.	2,975	2,286	1,551	968	1,724	1,310[a]	962	680[a]
32 U of Oregon, main	2,971	1,389	1,119	1,074	2,530	1,235	1,035	889
33 Florida State U	2,959	3,012	2,791	2,478	1,124	1,463	1,313	1,160
34 Ohio State U	2,907	3,227	2,654	2,039	2,355	2,679	2,144	1,743
35 Yale U	2,875	2,781	2,023	2,107	2,599	2,609[a]	1,886	1,750
36 Syracuse U	2,868	2,259	764	691[a]	1,278	551	396	327
37 State U of New York, Stony Brook	2,783	2,691	1,966	1,801	1,901	2,080	1,632	1,554
38 U of Pittsburgh	2,714	2,039	1,641	1,728	2,188	1,581	1,366	1,416
39 Wayne State U	2,656	2,261	2,163	2,022	1,799	1,636	1,640	1,555
40 Lehigh U	2,584	1,680	1,066	787	1,189	1,063	480	248
Total, first 40 institutions	**167,872**	**151,356**	**130,946**	**111,446**	**133,535**	**123,422**	**109,755**	**91,076**
41 Michigan State U	2,493	2,178	1,638	1,491	1,832	1,541	1,157	1,045
42 U of South Carolina	2,483	1,087[b]	970[a]	933	1,865	902[b]	816[a]	785
43 Colorado State U	2,479	2,385	1,973	1,774	2,230	2,079	1,717	1,579
44 U of Southern California	2,401	2,345	2,313	2,181	1,717	1,639	1,773	1,731
45 U of Iowa	2,331	1,822	1,488	1,185	1,195	923	807	447
46 Arizona State U	2,323	2,153	1,449	1,076	1,996	1,958	1,365	805
47 U of Oklahoma	2,306	1,399	1,275	869	1,067	674	617	441
48 U of Washington	2,276	1,500	1,326	921	1,775	1,404	1,117	828
49 U of Florida	2,248	2,302	2,283[a]	1,968	1,341	1,156	1,214[a]	1,339
50 State U of New York, Buffalo	2,242	2,203	1,665	1,143	1,528	1,626	1,163	817
TOTAL, FIRST 50 INSTITUTIONS	**$191,454**	**$170,730**	**$147,326**	**$124,987**	**$150,081**	**$137,324**	**$121,501**	**$100,893**
NATIONAL TOTAL	**$311,452**	**$285,520**	**$244,454**	**$206,421**	**$231,627**	**$216,630**	**$189,287**	**$156,516**

a Estimate. b Imputed. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

A fifth of academic physical scientists work at Mid-Atlantic schools, but West Coast schools account for biggest share of R&D outlays in physical sciences


WEST NORTH CENTRAL
Academic physical scientists 6.5%
R&D spending in physical sciences 4.1%
EAST NORTH CENTRAL
Academic physical scientists 17.1%
R&D spending in physical sciences 16.2%
NEW ENGLAND
Academic physical scientists 9.0%
R&D spending in physical sciences 13.7%
MIDDLE ATLANTIC
Academic physical scientists 19.9%
R&D spending in physical sciences 16.2%
MOUNTAIN
Academic physical scientists 5.5%
R&D spending in physical sciences 7.0%
SOUTH ATLANTIC
Academic physical scientists 15.1%
R&D spending in physical sciences 15.6%
PACIFIC[a]
Academic physical scientists 15.0%
R&D spending in physical sciences 18.2%
WEST SOUTH CENTRAL
Academic physical scientists 7.5%
R&D spending in physical sciences 7.4%
EAST SOUTH CENTRAL
Academic physical scientists 4.4%
R&D spending in physical sciences 1.7%

Key to map: Using the Middle Atlantic states as an example, 19.9% of all physical scientists employed at U.S. universities and colleges are located in this geographical area and 16.2% of all R&D expenditures in the physical sciences by universities and colleges are in this area. a Includes Alaska and Hawaii. **Note:** Data are based on 34,227 physical scientists employed at universities and colleges in the U.S. as of January 1983, and R&D expenditures of $821.5 million in the physical sciences during these institutions' 1982 fiscal year. Data exclude universities and colleges in outlying areas. **Source:** National Science Foundation

CHEMICAL DEGREES: B.S. degrees continue to rise for engineers, drop for chemists

Academic year	Degrees awarded in chemistry[a]			Degrees awarded in chemical engineering		
	Bachelors	Masters	Ph.D.s	Bachelors	Masters	Ph.D.s
1965–66	9,735	1839	1571	2848	994	354
1966–67	9,872	1831	1744	2869	949	305
1967–68	10,847	2014	1757	3211	1156	367
1968–69	11,807	2070	1941	3557	1136	409
1969–70	11,617	2146	2208	3720	1045	438
1970–71	11,183	2284	2160	3615	1100	406
1971–72	10,721	2259	1971	3663	1154	394
1972–73	10,226	2230	1882	3636	1051	397
1973–74	10,525	2138	1828	3454	1045	400
1974–75	10,649	2006	1824	3142	990	346
1975–76	11,107	1796	1623	3203	1031	308
1976–77	11,322	1775	1571	3581	1086	291
1977–78	11,474	1892	1525	4615	1237	259
1978–79	11,643	1765	1518	5655	1149	304
1979–80	11,446	1733	1551	6383	1271	284
1980–81	11,347	1654	1622	6527	1267	300
1981–82	11,062	1751	1722	6740	1285	311

a Does not include biochemistry and geochemistry. **Source:** Department of Education's National Center for Education Statistics

GRADUATE SCIENCE STUDENTS: 60% in physical sciences are studying chemistry

Thousands	1982	1981	1980	1979	1978	1977	1976
TOTAL							
Physical sciences	**26.5**	**25.8**	**25.4**	**24.9**	**24.7**	**24.8**	**24.8**
Chemistry	15.8	15.3	15.1	14.9	14.8	14.6	14.4
Physics	10.0	9.9	9.6	9.3	9.2	9.5	9.6
Engineering	**80.5**	**76.7**	**72.0**	**68.7**	**65.7**	**65.7**	**64.1**
Chemical	7.0	6.3	5.9	5.4	5.2	5.1	5.1
Metallurgical and materials	3.0	3.0	2.8	2.7	2.5	2.5	2.3
Petroleum	0.6	0.5	0.5	0.4	0.4	0.4	0.4
Life sciences	**42.0**	**41.8**	**42.5**	**42.5**	**43.0**	**43.0**	**41.8**
Biochemistry	4.1	4.0	3.9	3.9	4.0	3.8	3.7
Other sciences[a]	**198.4**	**195.9**	**194.0**	**184.5**	**176.4**	**173.1**	**167.5**
TOTAL	**347.4**	**340.2**	**333.9**	**320.6**	**309.8**	**306.6**	**298.2**
FULL TIME ONLY							
Physical sciences	**23.4**	**22.6**	**22.3**	**21.8**	**21.5**	**21.7**	**21.6**
Chemistry	13.8	13.2	13.1	12.8	12.7	12.6	12.4
Physics	9.0	8.8	8.5	8.3	8.2	8.5	8.5
Engineering	**49.1**	**45.2**	**42.3**	**39.7**	**37.4**	**37.0**	**36.4**
Chemical	5.5	4.9	4.4	4.2	3.9	3.8	3.7
Metallurgical and materials	2.5	2.4	2.2	2.1	2.0	1.9	1.9
Petroleum	0.5	0.4	0.4	0.3	0.3	0.3	0.3
Life sciences	**35.2**	**35.3**	**35.6**	**35.6**	**35.8**	**36.0**	**35.4**
Biochemistry	3.8	3.7	3.6	3.6	3.7	3.6	3.5
Other sciences[a]	**130.0**	**131.3**	**130.5**	**126.3**	**121.9**	**122.8**	**120.7**
TOTAL	**237.7**	**234.4**	**230.7**	**223.4**	**216.6**	**217.5**	**214.1**

a Includes environmental, mathematical, computer, health, agricultural, and social sciences and psychology. **Note:** Data for Ph.D.-granting institutions only. **Source:** National Science Foundation